DRAFT PLAN FOR RESEARCH IN INDUSTRY/AGRICULTURE/WATER

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Prepared by: PIER Process Energy Team

Wendell Bakken
Ricardo Amon
Tom Tanton
Prab Sethi
John Sugar

INDUSTRY/AGRICULTURE/WATER

PIER STAGE 2 PLAN

I. CURRENT SITUATION/BACKGROUND

The Industry/Agriculture/Water program area covers three distinct areas of "process energy". These three areas account for about 30 percent of California's electricity use. Industry, including food processing uses 22 percent of the electricity consumed in California. Agriculture comprises 3 percent of the state's electricity demand, largely for irrigation pumping. The water and wastewater industries in California account for 5 percent of demand. Most of this energy is used by municipal water and wastewater systems.

While each of these areas has unique research needs, they share some issues in common. The issues that the team has identified cover both unique and crosscutting research needs.

The Energy Commission has different levels of experience with each of the three areas. The Commission has programs that address each area.

The industrial program has the broadest focus; necessary because of the diversity in California's industrial base. The program has served as a liaison for federal programs that fund industrial efficiency efforts. The industrial portion of this PIER program area presents the greatest challenge for determining the most efficient focus for research. The diversity of industrial activity translates into diverse efficiency issues facing various industries, with a range of potential public benefits. The PIER team has worked to focus on issues that appear to cut across industries. These appear to offer greater potential public benefits than single industry problems. The Commission has conducted focus group meetings for ten different industries to review important research and development issues, opportunities and goals for industrial applications.

The Commission has conducted a program to encourage efficiency in agriculture for a number of years. We have developed contacts in the agricultural industry, and have a firm understanding of the general issues that confront agriculture in our state. The team has identified specific technical issues in this area.

The Commission has also started a program to encourage efficient equipment and practices in the water and wastewater industries. This program has worked with individual water delivery and wastewater handling agencies and professional associations. The focus has been at this level, rather than addressing problems with a system approach. This plan, on the other hand, addresses a number of water goals related to long run issues of supply and demand and considers some challenges for the overall state water system.

II. ISSUES

The Process Energy Team has identified issues which are both specific to program elements (such as water) and which cut across the elements to “process energy” in general.

These issues are:

1. The availability and cost of electricity for water delivery, application and/or processing affects competitiveness of industry and agriculture, as well as raises costs to municipal water and wastewater treatment systems.

The water in California does not naturally arrive year-round and in the same locations in which people use it. As a result, the state has extensive water storage and transport

infrastructure. Moving water to where it is finally used is energy intensive. Pumping water from aquifers, which tend to be deep in much of the state, is also energy intensive.

Domestic water use entails additional energy for water treatment and delivery. As regulations affecting the quality of domestic water supplies become stricter, water purveyors must adopt new technologies to remove salts and organic materials from supply water. These technologies will use significant amounts of electricity.

The wastewater from most domestic supplies then requires additional pumping and treatment. As environmental constraints on wastewater become stricter, that treatment will often require more energy as well.

As water demand in California increases, recovered water will probably have to play a larger role in the state's supply. In many cases, recycling water, and recovering water, that has been unsuitable for use, will be energy intensive efforts.

2. Increasing process efficiency through improved process management systems, equipment diagnostic systems and electro-technologies that reduce waste (reducing energy consumption), enhancing competitiveness of California industries.

Industrial processes offer a variety of opportunities to improve the efficiency of electricity use. Processes use electricity in a wide variety of ways.

Common themes, which focus group participants echoed, were industry's desires to have better sensors to control processes and provide warning of equipment failure. They also identified need for technologies or systems which reduce the amount of waste from processes.

In both, the cases of sensors for control and diagnosis and the case of reducing wastes which must be disposed, the issues cut across a number of industries and agriculture. Sensor development could improve the efficiency of electricity use in those industries that decide to use them. Waste reduction involves electricity-based solutions in some industries. In these cases, the cost of the additional electricity used in waste reduction may be significantly less than the savings in reduced waste or emissions mitigation.

Other issues that surfaced, and appear to deserve high priority are material drying technologies to reduce energy use and methods to recover and utilize waste heat more efficiently.

3. Development of electro-technologies to reduce the cost of disposing of industrial wastes will help the competitiveness of California industry.

Focus group participants repeatedly cited waste treatment and mitigation costs as a major impediment to profitable operation in California. The state's regulations regarding waste and emissions management were viewed as a major source of expense.

In a number of areas, participants believe that electro-technologies can be employed to reduce the cost of waste to industry and agriculture. Recovery of reusable components in waste streams can provide further economies for California industries.

4. On-site power quality and reliability improvements through new technologies can reduce production costs and increase competitiveness of California industry.

Industrial focus group participants repeatedly raised the issue of in-plant power quality as

an important problem in need of resolution. It appears that the problem is not with the quality of power coming into the plant, but with power characteristics (harmonics, power factor and noise) within industrial operations.

There are three aspects of power quality that the PIER program is concerned with:

1. maintaining a minimum level of quality at the distribution level (working in cooperation with utility distribution companies) incoming to individual consumers,
2. reducing the outgoing negative effects on grid level power quality from individual customers, and
3. improvements to processes and operations which would make them less sensitive or better able to deal with less than perfect quality.

The focus of the industrial/agriculture and water program will be on improving processes to be less sensitive to power quality problems, or to reduce the power quality problems they generate. The Strategic Research PIER program will include those issues related to power quality from the grid, and the issues of power quality problems that industrial operations send back to the grid from the process operations

5. Improvements in electric load management and metering technologies can reduce industrial and agricultural costs to improve business competitiveness.

This issue covered both industry's and agriculture's ability to shift peak electric demand out of the utility's peak load hours, and developing methods to aggregate the loads of remote accounts. Once the Competitive Transition Charge ends, and utility distribution companies have more latitude to adjust rates, load shifting and metering flexibility are likely to become more valuable.

The technologies necessary to shift electric load vary between industries and with the processes being used. Although a number of industries and agriculture may be able to benefit from technologies to shift load, the type of equipment or system necessary. This would result in a small market for any one technology developed. Additionally, manufacturers of metering equipment appear to be addressing the issue of aggregating loads. Any work in this area must demonstrate public benefits before it would be appropriate to consider PIER funding for research.

There is significant uncertainty surrounding the public benefits from research in this area. Staff has not yet to identify any goals to pursue in this issue for the Stage 2 process.

III. GOALS

The program team has developed a series of priority technical issues within the larger issues developed through focus groups and Policy Advisory Council input. These are culled from a larger population of technical opportunities that fall within the issue areas. These priority issues are the program "goals".

Below, we list the goals by the issues of which they form a part.

1) The availability and cost of electricity for water delivery and application.

a. Develop technologies to enhance the recycling, recovery and treatment of water for use as potable, agricultural and industrial supplies.

Early in the next century, demand for water in California will outstrip supply in an average water year. If the state's water system is to meet the needs of California's residents, more energy intensive efforts to produce water will be used. These may include more pumping from deep aquifers, desalination efforts, water conservation and wastewater recovery and recycling.

Undertaking research now in the areas of water recovery and recycling will help to develop systems and approaches that are less energy intensive than the current alternatives. New developments in reverse osmosis, which allow filtering water under lower pressure, are a good example of energy saving developments. These developments will both make energy use more efficient, and reduce costs for water users, including industrial and domestic water customers.

This goal benefits electricity customers statewide. Mainly domestic and industrial water users face the problem of water deficits in the future. Agricultural customers generally have contracts and water rights for a continuing source of water.

b. Develop crop water coefficients, software and/or hardware to improve energy efficiency for irrigation water.

In order for farmers to use irrigation most efficiently, they need to know when and how much water to apply to a given crop in each location. This is "irrigation scheduling", and requires the farmer to calculate the evapotranspiration rate of the crop, characteristics of the soil, and weather data.

Crop water use coefficients indicate how much water a crop needs during the growing cycle. Research is needed to develop crop and site specific water use coefficients, new generation hardware to determine soil water content, and user-friendly software to calculate evapotranspiration coefficients (etc) to determine when and how much water to apply to different crops in various locations in the state.

The primary beneficiaries from this work are farmers who use irrigation. They will use water more efficiently, reducing the pumping energy required per unit of agricultural output. Since one result of this work should be reduced water use for agriculture, the secondary benefits accrue to water users throughout the state who then benefit from increased water available.

c. Develop technologies for flexible irrigation district delivery systems, to reduce energy used for on-farm groundwater pumping.

An increasing number of farmers are adopting low volume irrigation technologies, especially in grape and tree crops. These systems require growers to irrigate frequently and for long periods of time. Most irrigation districts cannot deliver water on-demand, using flexible schedules. Therefore, farmers must pump groundwater from deep wells to irrigate when they use low volume systems. This pumping is energy intensive.

Overcoming this problem requires development of computer software models to allow irrigation districts to maintain constant water levels in canals for long periods. This would

allow currently available, automatic gate systems to provide the flexibility necessary for low flow irrigation.

This goal benefits growers served by irrigation districts throughout the state. The initial result should be energy savings, as growers can shift their water supply from deep wells to surface water. This will make use of low volume irrigation more economical by reducing the energy cost of those systems. We expect these changes to increase use of energy efficient irrigation systems, reducing the amount of energy used in agriculture, and also making water use more efficient.

2) Increasing process efficiency through improved process management systems, equipment diagnostic systems, and electro-technologies contributing to waste reduction can enhance competitiveness.

a. Develop advanced sensors, controls, diagnostic tools and smart motors to reduce electricity use and improve reliability for rotating machinery and process systems.

Focus group participants from a number of industries stated that development of advanced controls should allow their industrial processes to operate more efficiently. Participants also noted that advanced sensors could make it possible to identify process equipment that is likely to fail. This would allow them to perform equipment maintenance and repair before equipment failure disrupted production. The loss of production that this can cause in some industries decreases the energy efficiency of the process.

Staff believes that this is a priority objective. However, we have little information on industries or processes that can benefit. We also have little information on what other research may be going on in this area for specific industries or types of equipment. Before we can go forward, we must develop more information on the problem, and insure that our efforts provide public benefits.

b. Improve material recovery processes to reduce energy use and emissions.

Focus group participants identified material recovery as an issue in a number of industries. If recovery processes are successful, industries benefit by reducing costs of purchasing replacement materials, and waste disposal costs are reduced.
Pursuing this goal will require staff or technical support contractors to identify what materials are potentially amenable to recovery from process uses, and whether PIER funding there would provide public benefits

c. Research electro-technologies as alternatives to existing environmentally damaging chemicals.

As a result of environmental research, the Environmental Protection Agency (EPA) is requiring the phase-out of a number of chemicals used in industry. These include methyl bromide, which the agricultural industry widely uses as a pesticide. Methyl bromide increases the yield of some crops, and reduces post-harvest spoilage of produce. EPA has identified methyl bromide as an ozone depleting compound.

Research is currently underway on a number of electro-technologies and techniques to replace methyl bromide. Staff believes that there may be other potentially environmentally harmful chemical compounds, which may be supplanted by electro-technologies. PIER is currently supporting some research on ozone. One project, evaluating ozone as a soil fumigant, is showing that smaller doses of ozone are more beneficial than the original, larger

gas volumes which were tested.

This goal initially helps growers of crops using methyl bromide as a soil fumigant and the food processing industry using methyl bromide as a fumigant for stored produce. Over time, staff will conduct research to determine whether other, potentially harmful compounds, can be replaced through use of electricity.

d. Develop technologies and process improvements to reduce electric process heat demand and use waste heat more efficiently.

Waste heat recovery can reduce the energy cost of operating processes. While heat is often generated through fossil fuels, electro-technologies can serve to reduce the energy used in the total process. Using absorption cooling, for instance, electric heat pumps may be replaced, reducing electricity use, while continuing to recover heat for other process purposes.

Product drying is a large use of process heat. Research has been going on regarding alternative electro-technologies or systems to dry products. If successful, these may save large quantities of electricity, as they replace resistance heating. There is probably not one technical solution to all cases where drying is made more efficient. Staff intends to identify technologies or systems which offer the greatest public benefit in California.

While focus group participants raised the issue of more efficient use of process heat, staff has little specific information on what industries can benefit, and what the results would be. While the petroleum industry appears to be a leading candidate for this type of research, other industries are also likely to benefit from work in this area. As in other goals, public benefit from any PIER expenditures is a paramount consideration.

e. Alternative Uses of Industrial Waste Products

Waste disposal, and emissions mitigation costs are a large expense to industry and agriculture in California. Where research and development can identify uses for waste products, costs to industry of disposing waste are reduced. Such developments also make more efficient use of materials, further reducing costs.

3) Development of electro-technologies to reduce cost of disposing of industrial wastes.

a. Develop technology to better utilize energy in filtering and cleaning technologies, separating recyclable components.

Focus group participants were adamant that reducing costs of emissions and waste disposal are paramount issues in competitiveness of California industries. Pursuing better technologies for filtering and cleaning of products and process waste is an important part of reducing wastes from industries. Reuse of materials that would otherwise be discarded reduces cost of industrial operations.

b. Develop technologies to reduce the amount of energy used for wastewater pumping and treatment.

As is the case in water supply, water pumping and treatment are significant electric loads in industry and municipal operations. Technologies that allow these functions to be performed more efficiently benefit the public through lower municipal costs and benefits industries which have large quantities of waste water. Those industries include food processing and

the petroleum refining industry.

c. Electro-technologies to reduce waste and pollutant emissions at lower cost.

Emissions of pollutants is a major problem for California industries. Our state has the most stringent emissions regulations in the nation, complicating industrial operations which emit pollutants. Reducing these costs to industry can make it possible to maintain or increase industrial production, where emissions have been a problem.

d. Reduce the impact of on-site power quality and reliability through new and/or improved technology and demonstration.

Should the initial study determine that further PIER efforts are justified, we would carefully define the PIER role, either to augment other research going on in this area or to undertake study in an area which has not received attention.

4) On-site power quality and reliability improvements can reduce production costs.

a. Conduct a technical study to understand the source and root cause of on-site power quality problems affecting industry.

Focus group representatives from a number of industries, especially computers and electronics listed power quality as a significant issue facing them. The problem, however, appears to be different for each industry. There are various sources of poor quality power, and different problems from poor power quality which depend on the industry or process under consideration. In some cases, such as agriculture, the issue of voltage at the end of long distribution lines is largely unique to that sector. This issue is not well defined enough to pursue without further study. Our review of existing research shows considerable effort from other researchers going into specific elements of on-side power quality. This may offer an opportunity to leverage PIER funds. Conversely, we may find that others are taking care of the issues, saving PIER funds for other opportunities.

IV. GOALS AND OBJECTIVES

The process energy team has developed an objective for each of the goals that have high priority. Where we have experience with an issue, the goal represents our estimate of what new technology should be able to provide in improved efficiency. Where our experience is thin, our estimates reflect what we believe new technologies, systems or approaches can achieve. As we accumulate more information and expertise in these areas, we can refine the estimates.

Program Goals	Objectives
I. Cost of electricity for water delivery and application or processing raises costs to municipalities and industry.	
a. Technologies to reduce fresh water pumping energy use by water recycling, recovery and treatment.	Develop technologies to reduce fresh water pumping energy by ten percent per unit of water within five years. (priorities a, b and c)
b. Crop use coefficients and software	Develop technologies to increase irrigation energy efficiency by 15 percent within 5 years
c. Technologies for flexible irrigation district delivery	Develop technologies to increase irrigation energy efficiency by 15 percent within 5 years
II. Increasing process efficiency through process management systems, equipment diagnostic systems, and waste reducing electro-technologies.	
a. Sensors, controls and diagnostic tools	Develop technologies to reduce electricity use per unit of production by at least 15 percent,
b. Reduce energy use and emission of pollutants in material recovery	within five years, for priorities a and b.
c. Research electro-technologies as alternatives to existing environmentally damaging chemicals.	Develop technologies to maintain at least 90% yield, costing less than 10% over cost of existing chemical application within 5 years.
d. Technology and process improvements to reduce electric process heat demand and use waste heat more efficiently.	Develop technologies to reduce electricity used in process heat, in selected applications, by 15% within 5 years.
e. Alternative uses of industrial and agricultural waste products.	Develop inventory of likely products with information to set priorities, within one year.
III. Development of electro-technologies to reduce cost of disposing of industrial wastes.	
a. Technology to better utilize energy in filtering and cleaning technologies, separating recyclable components.	Develop inventory of likely industries and processes for R&D within one year.
b. Technologies to reduce the amount of energy used for waste water pumping and treatment.	Reduce waste water pumping and treatment energy requirements by 10% per unit of wastewater treated, within 5 years.
c. Electro-technologies to reduce waste and pollutant emissions at lower cost.	Develop inventory of most likely industries and processes for R&D, within 2 years.
IV. On-site power quality and reliability improvements through new technology	
a. Study of root cause of on-site power quality problems.	Determine whether a pervasive unmet need for research exists, within 1 year, for up to $250K.
V. Account and Load Management	No Priority Goals

V. CURRENT RESEARCH

A. Current PIER Activity

The PIER program is currently funding research activities for the metals processing industry, food processing industry, agriculture and municipal water and wastewater operations.

Metals Processing

Through the transition solicitation, PIER is funding development of a pilot size low-dross aluminum melter with Edison Technology Solutions. This electric melter operates with less waste metal than current technologies. Its success should reduce the cost of recycling aluminum by reducing the amount of energy required for melting and reduced waste costs.

The product of this contract is a pilot one ton melter.

Food Processing

Through the second general solicitation, PIER is funding a testing and demonstration project at the Foster Farms poultry processing plant in Livingston. This undertaking will use ozone and micorfiltration in place of some chlorine to treat water used to wash processed poultry. This process should significantly reduce the amount of water used by allowing recycling of the chilled wash water. Savings from the project accrue to both the processing plant, and the municipal wastewater treatment agency, which pumps and cleans the waste from the plant.

Agriculture

Through the Transition Solicitation, PIER is funding a project involving testing and demonstration of a number of advanced agricultural technologies. Edison Technology Solutions, the contractor, is working with EPRI to develop technologies to improve farm productivity, reduce use of toxic chemicals without adversely affecting farm production, reduce energy consumption and reduce water use. The entire project has a budget of $320,000 for the transition stage.

The elements of this project include:

1. Ozonation for soil fumigation.

   The agriculture industry in California currently fumigates land, prior to planting, with methyl bromide. Methyl bromide is an ozone depleting chemical, which will be phased out by international agreement . Soil fumigation increases the yields significantly for a number of crops.

   Injecting ozone into the soil as a pre-planting fumigant may accomplish the same results as use of methyl bromide. If tests are successful, agricultural producers will be able to phase out use of methyl bromide without significant crop losses, and increased cost of their products.

   The product is a report on test results.

2. Ozonation of Irrigation Water

   Anecdotal evidence suggests that ozonation of irrigation water can reduce crop water consumption, increase crop yield, reduce the amount of fertilizer needed by crops and reduce fungal attack at the root level. The project involves scientific testing of the impacts of ozonated water for irrigation, to determine its effects on productivity and costs of growing.

   The product is a report on test results.

3. Ozonation as an Aqueous Disinfectant and Gaseous Fumigant

   The agricultural industry routinely uses chemical fungicides to preserve fresh fruits and vegetables after harvest. This element of the contract involves testing ozone as a replacement for fungicides in the water used for washing post harvest produce. The approach will be evaluated for its impact on the quality of the produce, as well as its effectiveness as a fungicide.

   Methyl bromide is often used as a fumigant to preserve stored produce. This part of the project involves full-scale testing of ozone as a replacement fumigant for methyl bromide, on a variety of stored crops.

   The product is a report on the 1998 post-harvest field test.

4. Controlled ventilation for storage of fruits and nuts

   This element of the project involves replacing the use of methyl bromide for post - harvest storage of fruits and nuts. The researchers will employ a variety of methods to keep the stored product cool during storage. The project will employ optimized fresh air, evaporative cooling and refrigeration for pest and insect control.

   The product is a report of effectiveness following the 1998 season.

5. Livestock Waste Management

   The project will demonstrate new water treatment technologies to prevent ground water contamination and facilitate processing of the wastes to promote recycling. This effort includes tests of advanced solid-liquid separation. The test solid separation process will remove organic and inorganic matter from liquid manure, to meet both water quality regulations to protect groundwater, as well as to meet air quality regulations regarding ammonia vapors.

   The product is a conceptual design and demonstration report.

6. Irrigation Scheduling

   The irrigation scheduling element of the project involves testing a number of methods to determine optimum irrigation schedules for crops. If these are successful, the amount of water used for irrigation will be reduced, saving energy for pumping, as well as freeing up water for other purposes.

   The project is based on recent developments in sensors and electronic data collect to automate monitoring of soil, plant and weather characteristics. These include integrated automated weather stations, soil moisture probes and sensors to measure

fruit tree trunk diameter.

The product is a pilot phase report.

Water Supply and Wastewater Treatment

Edison Technology Solutions has contracted through the PIER transition process and the first general solicitation to conduct a variety of research activities in the area of water supply and wastewater treatment. EPRI is a participant in these research efforts. The transition contract is for $410,000. The first solicitation contract totals $2.9 million. These two contracts include the following elements:

1. Solids Removal and Salinity Reduction (Transition and First Solicitation Contracts)

The solids removal portion of this project will evaluate performance of solids removal technologies for surface water, municipal wastewater and agricultural drainage. The project will test conventional solids removal treatment, conventional treatment with ozone and biologically active filters, microfiltration and ultrafiltration membranes.

The salinity reduction element of these projects involves developing a carbon aerogel, capacitive deionization system and new technology filtering membranes using low pressure reverse osmosis and extremely fine "nanofiltration" membranes.

If successful, these technologies will initially to allow wider use of Colorado River Water, which is saline. The techniques range from approaches that are still in initial development to technologies in pilot scale operation.

The products are task reports on the technologies in early stages of development, to evaluations of pilot plant operation for the more mature processes.

2. Pulsed Ultraviolet Light (UV) and Ozone for Disinfection and Membrane Fouling Control (Transition and First Solicitation Contracts).

This project demonstrates the use of concentrated UV in short, high-intensity pulses to kill microorganisms and to control fouling by biological materials on membranes. It also involves testing ozone as a post-filtration treatment to kill microorganisms. These options will avoid use of chemicals, heat or ionizing radiation. The technology will be tested for surface drinking water treatment as well as wastewater treatment. In particular, the project will test effectiveness on *cryptosporidium.*

The products will be reports on pilot scale test results, and recommendations for research and improvements necessary for commercial development of the technology.

3. Bromate Formation and Control During Ozonation (Transition Contract).

Bromate is a potential carcinogen formed when water containing bromide is ozonated. This element of the contract involves investigating the formation and control of bromate at ozone levels capable of controlling *cryptosporidium.* Bromate may be the primary limiting factor for use of ozonation for water disinfection.

The product is a task report.

4. Disinfection of Reclaimed Wastewater with UV (Transition Contract).

   This element of the project involves operating a UV system to disinfect wastewater. This pilot effort provides an opportunity to compare the effectiveness of UV with chlorination and ozone.

   The product is a task report on pilot system effectiveness and recommendations for further work needed for commercialization.

5. Demonstration and Evaluation of Low Pressure Membranes (Transition Contract).

   This element of the project will test the effectiveness of experimental and commercial microfiltration and ultrafiltration membranes as a pretreatment to reverse osmosis. Success in this effort would result in more efficient, and less energy intensive operation of reverse osmosis systems.

6. Denitrification of Wastewater

   The contractor will undertake a full scale test of methods to denitrify wastewater. This effort will include modifications to a full size wastewater treatment plant. The project will determine the most efficient method to meet new standards for nitrogen removal in the discharge of treated wastewater to surface water.

   The product will be a task report on the effectiveness of the equipment modifications and energy impacts. The report shall include recommendations on optimizing the treatment system.

7. Advanced Oxidation to Remove Synthetic Compounds (First Solicitation).

   This task evaluates two advanced oxidation processes for their ability to break down synthetic compounds in surface water and ground water: pulsed UV with addition of hydrogen peroxide and ozonation with addition of hydrogen peroxide. The testing will focus largely on the techniques' impact on methyl tertiary butyl ether (MTBE) as well as on perchlorate among other synthetics.

   The product will be a report evaluating the effectiveness of these methods on removing these compounds and evaluation of the formation of disinfection byproducts.

   A. Other Research Related to Stage II Goals

<u>General Industrial</u>

Staff is working with Oak Ridge National Laboratories (ORNL) to identify research directly related to the goals which are identified in the Stage II plan. The information that ORNL provides, as well as further staff research will expand the number of known research efforts related to our goals.

Staff is working with the Office of Industrial Technology (OIT) at the U.S. Department of Energy in the "Industries of the Future" program. The Energy Commission will be targeting the petroleum refining, chemical and pharmaceutical, glass, paper and pulp, computer, electronics and aerospace industries for further research.

Agriculture and Water

Many of the problems which agriculture and water research can address for California are regional. A significant number of California's agricultural problems are related to specific crop/climate conditions, and the way California's water supply is managed. Many water-related issues are related to California's water supply sources and system. Other issues are national in scope (such as Clean Water Act requirements), in which EPRI is involved. The research cited in these areas forms a much more comprehensive list of external activities.

Program Goals	Research
I. Cost of electricity for water delivery and application or processing raises costs to municipalities and industry.	
a. Technologies to reduce fresh water pumping energy use by water recycling, recovery and treatment.	ORNL: Efficient Pump/Motor Technologies EPRI: Effects of Disposal of Seawater Desalination Discharges EPRI: Computer Management of Water Systems Weyerhauser Corp.: Industrial Water Recovery
b. Crop use coefficients and software	UC Davis, Irrigation Program: Crop Coefficients CalPoly San Luis Obispo Irrigation Technology Research Center: System Design Fresno State University, Center for Irrigation Technology: Technology Assessment USDA Agricultural Stations: Basic Research Private sector companies: Orange Software, Netafim, others
c. Technologies for flexible irrigation district delivery	CalPoly San Luis Obispo Irrigation Technology Research Center: Technology Assessment System Design, Operation Efficiencies Idaho National Engineering and Envir. Lab: Precision Farming Technologies. ORNL: Assessment of Precision Farming Technologies in the Southeast States.
II. Increasing process efficiency through process management systems, equipment diagnostic systems and waste reducing electro-technologies.	
a. Sensors, controls and diagnostic tools	ORNL: Sensors and Controls for Automated Manufacturing and Fault Detection and Diagnosis. Univ. of Tennessee: Technologies To Reduce Equipment Downtime
b. Reduce energy use and emission of pollutants in material recovery	EPRI: Low-Dross Aluminum Melting ORNL: Oil/Water Separation in Drilling
c. Research electro-technologies as alternatives to existing environmentally damaging chemicals.	EPRI: Utilization of Ozone in Production Agriculture EPRI: Semiconductor Chip Dry Cleaning by Lasers
d. Technology and process improvements to reduce electric process heat demand and use waste heat more efficiently.	ORNL: Advanced Desiccant Systems EPRI: Induction Curing of Coatings EPRI: Induction Hardened Power Metal Gears EPRI: Laser Heat Treating EPRI: Non-thermal Processing using Pulsed Electric Fields EPRI: Non-thermal Processing of Foods EPRI: Impulse Drying of Sludge EPRI: Electrostatic Removal of Moisture for Enhanced Agricultural Drying ASHRAE: Absorption Heat Pump Heat Recovery for Petroleum Refining ORNL: Variable Frequency Microwaves for Drying Produce
e. Alternative uses of industrial and	

agricultural waste products.	
III. Development of electro-technologies to reduce cost of disposing of industrial wastes.	
a. Technology to better utilize energy in filtering and cleaning technologies, separating recyclable components.	EPRI: Infrared Sand Reclamation EPRI: Freeze Concentration of Dairy Products
b. Technologies to reduce the amount of energy used for waste water pumping and treatment.	EPRI: Freeze/Thaw of Water Treatment Plant Residuals EPRI: Low Ozone Effluent Treatment for Toxicity
c. Electro-technologies to reduce waste and pollutant emissions at lower cost.	EPRI: Electric Arc Furnace Air Pollution Control System EPRI: Microwave Separation of Industrial Sludges EPRI: VOC Mitigation from Refining and Petrochemical Air Streams EPRI: Reduction of VOC emission from Wood Drying
IV. On-site power quality and reliability improvements through new technology	
a. Study of root cause of on-site power quality problems.	EPRI: Various Studies of Specific Equipment Issues in Power Quality

The Office of Industrial Technology, in the U.S. Department of Energy, is working with industries to develop "technology roadmaps". These roadmaps outline research and development priorities for the industries involved. Staff is becoming more familiar with the federal program. This will allow us to determine how best to apply PIER funding to maximize California's benefits from the federal efforts.

The petroleum and natural gas industries is a large consumer of electricity in California, and provides a substantial number of jobs in our state. This industry, broadly speaking includes extraction, refining and distribution elements. This is one of the largest industrial segments in size and importance to California's overall economy and consumption of electricity. The specific opportunities for advances to the technologies and techniques used in this industry have not yet been defined by our efforts. In furthering the planning of activities for this critical industry, the CEC has included the Natural Gas, Petroleum and Chemicals industry target as part of our membership in EPRI. Through the effect we expect that in mid-year 1999, we will have a better focus on appropriate opportunity in this sector for PIER research. A small (circa $10-15k) roadmapping activity may be appropriate to facilitate that, in conjunction with national "Industries of the Future" roadmapping exercises carried out by DOE.

VI. PROPOSED FUNDING AND PROCUREMENT APPROACH

Staff has a number of options to fund research addressing the identified goals. These options include:

- "Request for Proposals" (RFP), where we describe the work to be done, and bidders propose a course of action and give their price,
- Request for Qualifications (RFQ), where we describe the problem we want to have addressed, and bidders describe what they think should be done and negotiate what they would charge to do it,
- Sole Source Request, where staff and the Committee agree on a contractor who has unmatched credentials in the specific area of research under consideration, and award the contract to them.
- Interagency Agreement, where the Energy Commission may contract with another public entity or utility without competition, and
- Negotiated Request for Proposals, where Commission staff provide guidance to bidders regarding appropriate content in the proposals.

With each of these approaches, staff must decide whether a "project" or "program" approach is the most effective way to proceed. A "project" contract or agreement involves the contractor completing an agreed upon project to reach a goal. A "program" agreement covers a larger span than one project, and may be structured to provide latitude to the contractor for achieving an end result, with the contract language being less specific than that required of a "project".

The considerations which staff must address in its decisions regarding how best to fund research in each goal include:

- The staff resources required by each of the contracting options,
- How best to capitalize on existing research efforts and "leverage" PIER funds for greatest effectiveness,
- The time required to complete a contract or agreement through each administrative path,
- Whether contractor flexibility or completion of specific tasks is most important in the effort.

The limiting resource in the industrial, agricultural and water program is staff time. The PIER effort relies on staff that is operating ongoing delivery programs. Staff members in the industrial program are implementing the federal Department of Energy's NICE[3] Program, and working to expand our contacts in the industrial sector. The Agriculture Program staff is administering a loan program and technical assistance contracts. The water program staff person is responsible for implementing the Commission's technology transfer work among water purveyors.

The agriculture and water programs have had the most contact with leaders in their respective industries responsible for product or system innovation. In both areas, either public universities or nonprofit organizations are primary innovators. These areas probably lend themselves most to program-type contracts. Here, the Energy Commission relies on the contractor to assist in setting the goals for the contract, and may undertake a variety of projects to achieve the program goals.

The projects that are related to more general industrial needs are more likely to be addressed through RFPs. The initial efforts among these goals will probably be contracts to more closely define industrial needs, and determine which industries offer the most potential benefits from PIER intervention in research.

The team has identified approximately $4 Million in research that could be undertaken in this fiscal year to address program goals. Our initial estimates for expenditures for next fiscal year total approximately $4 Million as well. Staff and contractors will research our goals, as they relate to specific industries. As this work provides more detailed information, we will be able to identify more appropriate research in our goal areas.

The team proposes the following approach for the first year of Stage II effort, through June 2000.

Goals	Funding Approach	Timing of Solicitation
I. Cost of Electricity for Water Delivery and Application		
a. Technologies for water recycling, recovery and treatment.	Program Solicitation	Begin by June 1999
b. Crop use coefficients and software	Interagency Agreement or Program Solicitation	Begin by January 2000
c. Flexible irrigation district delivery tech.	Interagency Agreement or Program Solicitation	Begin by June 2000
II. Increase process efficiency		
a. Sensors, controls and machinery diagnostics	Program Solicitation for an initial study	Begin by January 2000
b. Energy use and pollutant emissions in material recovery	Not determined	Postpone for first year
c. Electro-technologies as alter. to chemicals	Program solicitation	Begin by January 2000
d. Reduce process heat demand	Tech. support contract or program solicitation	Begin by January 2000
e. Alternative uses of waste products	Not determined	Postpone for first year
III. Reduce cost of waste disposal		
a. Better utilize energy in filtering and separating recyclable materials.	Interagency agreement or program solicitation	Begin by January 2000
b. Reduce energy used for waste water treatment	Program solicitation or RFP	Begin by January 2000
c. Reduce industrial emissions	Not determined	Postpone for first year
IV. On-site power quality and reliability		
a. Analysis of causes of power quality problems	Technical Support Contract or RFP	Begin by January 2000
V. Account and Load Management	No priority goals identified yet.	